Stream Bank Repair Manual

COOPERATIVE EXTENSION
College of Agriculture, Forestry and Life Sciences

FOR SOUTH CAROLINA

LEARN COST-EFFECTIVE TECHNIQUES TO STABILIZE ERODING STREAM BANKS AND PROTECT DOWNSTREAM WATER QUALITY.

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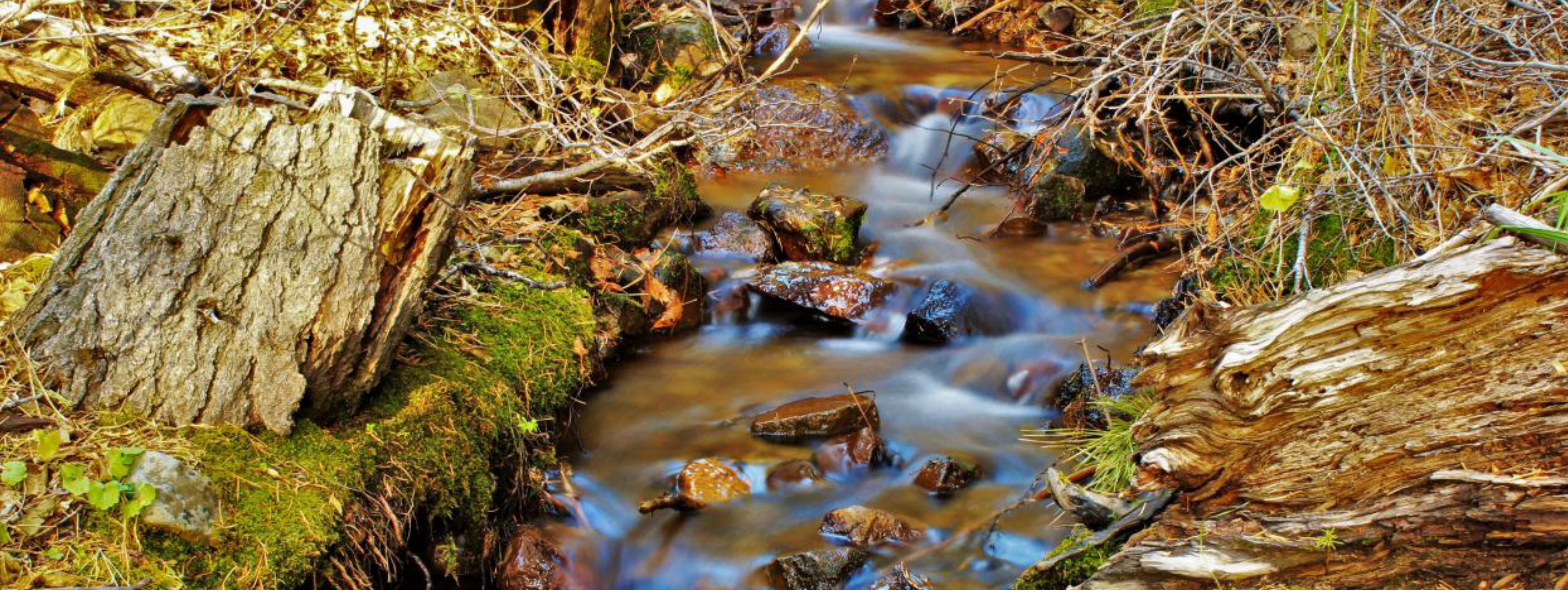

Stream Bank Repair Manual for South Carolina

An important part of a healthy stream is a stable stream bank. In this manual, you will learn techniques to help stabilize your stream bank to protect property, habitat, and water quality.

Healthy Streams

Healthy streams provide countless benefits to nearby communities and the surrounding ecosystem. These benefits include abundant recreational opportunities such as fishing, boating, and swimming. These activities define our South Carolina way of life and support the local economy. Healthy streams also help to reduce downstream flooding, increase property values, and protect drinking water. In fact, surface water from streams, rivers, and lakes provides 3.6 million residents of South Carolina with water for drinking.

So, what makes a stream healthy? **Floodplain connection is a critical characteristic of healthy streams, regardless of stream shape or size.** A floodplain is a low-lying area adjacent to the stream where water can spread out and slow down during high flow events. When humans alter banks and cut streams off from floodplains, the water velocity can increase, which exacerbates erosion and other issues. A floodplain that maintains connection to a stream will help provide flood protection to homes and businesses. In the floodplain, water infiltrates back into the soil and recharges groundwater supplies, an important source of freshwater for humans. Floodplains also work as filters, protecting aquatic habitat by allowing sediment and nutrients to settle to land rather than accumulating in streams.

In addition to floodplain connection, other characteristics of healthy streams include:

- A stream channel that meanders (**Figure 1**); the bends and curves help to slow water as it travels downstream.

Figure 1: A healthy meandering stream found in the Upper Broad River Watershed. Photo credit: Karen Jackson.

- A stream channel containing fallen logs and leaves creates habitat for aquatic organisms, the base of the food chain (**Figure 2**).
- Riparian buffers adjacent to the stream and comprised largely of native plants adapted to withstand fluctuations in temperature, water levels, and sunlight.

Figure 2: A small headwater stream in the Catawba Watershed has a diversity of in-stream materials, including large woody debris and leaf litter. Photo credit: Karen Jackson.

Unhealthy Streams

Erosion of stream banks and stream channels is an indicator of an unhealthy stream. Signs of erosion include exposed roots, vertical slopes, and slumping banks (**Figure 3**). Often, these streams have been straightened or channelized, which causes water velocity to increase, adding stress to stream banks (**Figure 4**). Eroding banks can result in property loss for residents and an increased risk for community flooding.

Erosion of stream banks will increase the amount of sediment in the stream. This excess sediment can damage the gills of macroinvertebrates and fish, increase water temperature by absorbing sunlight, and fill in spaces used for habitat and spawning. Furthermore, harmful pollutants such as bacteria, pesticides, and fertilizers bind to sediment particles and degrade water quality when entering a stream.

Figure 3: Erosion of surrounding sediment has exposed the roots of this streamside tree. Photo credit: Karen Jackson.

Figure 4: Channelized streams increase velocity and can lead to down-stream flooding and erosion. Photo credit: Karen Jackson

Benefits of Riparian Buffers

An important part of repairing stream banks is encouraging healthy riparian buffers. Residents can establish riparian buffers to improve the health and stability of stream systems. Riparian buffers are an essential transition area between water and land, supporting **diverse food webs** and functioning ecosystems. Instream organisms use leaf litter from surrounding vegetation for food and habitat. The cycle continues as insects emerge from aquatic larval stages and become food for terrestrial species like birds, spiders, and reptiles.

Riparian buffers provide shade to the stream and help **regulate water temperature**. Aquatic organisms, fish, and macroinvertebrates are only able to survive within a specific range of temperatures. Excessive high temperature can lead to algal blooms, which are unsightly and can result in low dissolved oxygen when the algae decompose. Temperature can also directly affect dissolved oxygen because warm water holds less oxygen than cooler water.

Riparian buffers help to **filter pollutants** that come from land. These pollutants include sediment from land disturbance, excess nutrients from fertilizer, and bacteria from pet or wildlife waste. Many studies have shown that a buffer as narrow as 15 ft. can substantially reduce pollutants making their way into the stream.

Streams are naturally dynamic systems that respond over time to differences in the landscape by widening, changing depth, or meandering. In a relatively stable landscape, these changes happen gradually. However, when changes to the landscape happen quickly due to human activities, the stream may adjust in dramatic ways. For instance, increased water velocity caused by the added stormwater runoff associated with a new development may result in dramatic scouring or deepening of a stream system. A healthy riparian buffer can help to dampen impacts from the surrounding watershed, which allows the stream to function more naturally and reduce negative impacts to surrounding communities.

Addressing Unhealthy Streams

There are a variety of practices that can address issues in an unhealthy stream. This manual focuses on a set of practices designed to repair and stabilize unhealthy stream banks. It is important to distinguish between these stream bank repair practices and stream restoration.

Both stream bank repair and steam restoration can provide habitat enhancements and pollution reduction by creating healthy buffer areas along streams. Both encourage floodplain connectivity and more stable banks.

Stream bank repair provides some of these benefits with little or no regulatory permitting, low costs, and limited training. Homeowners and property managers can put these practices into action after receiving minimal training or instructions. All of this is possible because stream bank repair practices stay above the ordinary high water mark (see permitting section below) and outside of the stream channel.

More severely impaired streams may require a more extensive stream restoration. Stream restoration requires trained engineers, a longer timeline, more permitting, and a higher price tag. Stream restoration is not limited to stream banks and may include more complicated practices like in-stream structures, channel realignment, and dam removal. If you're unsure whether you need a bank repair or stream restoration, contact your local Clemson Extension Water Resources Agent for guidance at www.clemson.edu/extension/water.

Special Considerations

Site Selection

Not all sites are suitable for stream bank repair. Stream bank repair practices are most successful in smaller, headwater streams, known as first or second order streams. A first order stream is the beginning of the river network and has no contributing tributaries. A second order stream occurs when two first order streams merge (**Figure 5**). Streams with large drainage areas or high levels of impervious surfaces are susceptible to rapid increases in water level and velocity, which increases the risk of damage to stream bank repair work. Severely degraded sites may require a more extensive stream restoration as previously mentioned.

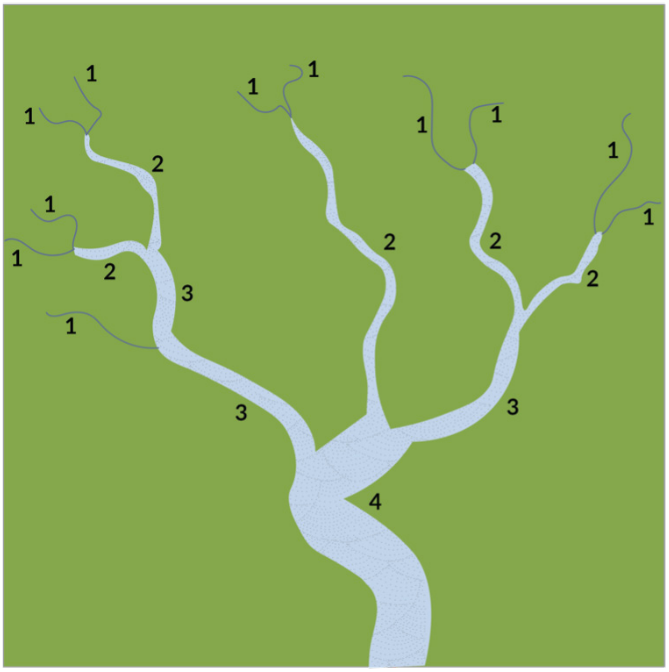

Figure 5. The Strahler Order illustrates stream network by way of tributaries. First order streams, also called headwater streams, can join another first order stream to become a second order stream. As the order increases, so does the drainage area. Graphic credit: Kim Morganello

In some situations, vegetation and erosion control matting is not sufficient to prevent bank erosion. In these instances, stream banks can be stabilized using riprap. Riprap consists of large, irregularly shaped rocks along an area of stream worn down by the constant flow of water. Unfortunately, water often finds its way behind these materials, causing the installation to dislodge and fail over time (**Figure 6**). Native vegetation can be installed in between riprap. Riprap will provide immediate protection, while native plants will provide long-term protection as they establish.

Figure 6: Turfgrass borders a small stream in the Pee Dee Watershed. Riprap has been used to stabilize the eroding banks but has fallen into the stream. Photo credit: Katie Altman

Permitting

As described in this manual, stream bank repair practices are covered by nationwide permits and should not require additional permitting from a regulatory agency. Stream bank repair activities addressed in this manual should be completed above the **ordinary high water mark** (**OHWM**). The OHWM is the line along the bank established by water fluctuations and is identified by changes in soil, vegetation, or debris (**Figure 7**). Work done below the OHWM may require permitting through the Army Corps of Engineers (USACE) and the South Carolina Department of Health and Environmental Control (SCDHEC).

Before initiating stream bank repair work, communicate your planned activities with USACE and your local municipality to ensure you do not need a permit.

Figure 7: The blue line along this stream indicates the ordinary high water mark. A change in vegetation or soil is a good indicator of the OHWM. Photo credit: Katie Altman.

Stream Bank Repair Options

The following stream bank repair options can help you choose the method that best fits your site conditions and available resources. Decide which option is best for you, then reference the practices listed in the following section.

Option 1:

Grade banks to a 3:1 slope and plant native species
Practices 1-5 (see the following section)

Grade the bank to a 3:1 slope, install erosion control matting, and livestake with native species. Option 1 is ideal if:

- Access to a small backhoe or mini excavator is possible.
- Utility lines are not present.
- Stream Bank Repair does not interfere with permanent structures.

Option 2:

Plant native species without grading banks
Practices 2-5 (see the following section)

Install livestakes to an eroding stream bank with exposed soil. Option 2 is suitable if:

- Access to machinery is either not possible or limited.
- Space to pull back the stream is limited and would interfere with established walkways, paths, or permanent structures.
- Utility lines are present.
- Limited financial resources are available.

Option 3:

Create a no-mow zone
Practice 5 (see the following section)

Create an area at least 15 feet in width along the stream bank where mowing is limited. Option 3 may not provide the stability gained from Options 1 and 2 but is preferable to bare soil or mowed turfgrass. Option 3 is best if:

- Time or ability to install other practices are limited.
- Financial resources are not available.

Stream Bank Repair Practices

Practice One: Adjust the slope of the stream bank

Regrade steep stream banks to a gentler slope. When possible, grade banks to a 3:1 slope, or a slope that is three times longer horizontally than vertically (**Figure 8**). Measure the vertical height from the Ordinary High Water Mark to the top of the stream bank. Multiply this measurement by three. The resulting number is the width to which the stream bank should be pulled back, beginning at the OHWM. Use a backhoe or mini excavator to regrade banks. For small streams, a shovel and manual labor may be appropriate for regrading. **Avoid discharge of soil or other material into the stream.**

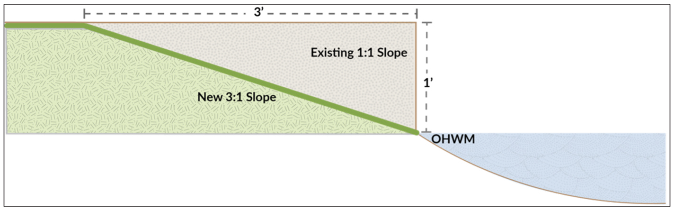

Figure 8: Diagram detailing how to measure and calculate a 3:1 slope. Start by measuring the vertical distance (height) from the OHWM to the streambank. Multiply this number by 3 to get a 3:1 slope. Graphic credit: Kim Morganello.

Practice Two: Prepare soil and seed

Remove any invasive plants present. While streamside vegetation is essential, invasive species should be avoided or removed. Invasive species outcompete native plants that are beneficial to local pollinators and wildlife. Invasives can be removed by hand or by using herbicides labeled for aquatic use. Contact your local Extension office if you plan to spray herbicides near a waterway. Visit *https://www.invasiveplantatlas.org/list.html?id=27* for information on invasive plants in South Carolina.

Before planting, loosen the soil to allow for root infiltration and growth. Lightly rake the area to ensure seeds have maximum contact with soil. Spread a riparian or wetland seed mix that contains native species (**Figure 9**). A spreader can help achieve a more uniform seed coverage. Lightly cover the area with straw.

Figure 9: Workshop participants spread native seeds along the riparian area. Photo credit: Karen Jackson.

Practice Three: Install erosion control matting

Use an erosion control mat made from natural coir or coconut fiber to stabilize exposed soil and seeded areas. Select a mat that does not have synthetic material (plastic), as this can harm wildlife. Use tightly woven matting at sites with steep slopes and high water velocity.

To install erosion control matting, lay out the matting along the bank and dig trenches that will help keep the matting in place. These trenches should be at least six inches deep. Dig one trench along the upstream portion of the mat, perpendicular to the stream (**Figure 10**). Dig a second trench parallel to the stream at the top of the mat farthest from the stream. Place the ends of the mat into the trenches and cover with soil. Hammer 12-18 inch wooden stakes through the mat every 3 feet, to secure it during high flow events (**Figure 11**).

Figure 10: A trench 6 inches deep is dug parallel to the stream. The erosion control mat is secured by inserting the edge of the mat into the trench and backfilling. Photo credit: Katie Altman

Figure 11: Use wooden stakes to secure the erosion control mat. Insert stakes approximately every 3 ft. Photo credit: Katie Altman

Take extra precautions to ensure the erosion control matting is not dislodged from the upstream trench. One option is to insert a 1-inch roofing nail about an inch below the top of the wooden stakes on the upstream side (**Figure 12**). The nail will help prevent the matting from becoming displaced during high streamflow. If children or pets are present and there are safety concerns, consider using eight inch biodegradable stake on the upstream end instead (**Figure 13**).

Figure 12: Add roofing nails to the wooden stakes on the upstream end of the erosion control matting. The roofing nail will help prevent the mat from pulling loose during high streamflow. Photo credit: Katie Altman

Figure 13: Biodegradable stakes can be used instead of roofing nails to better secure the upstream side of the mat. Photo credit: Katie Altman

Practice Four: Install livestakes

Livestakes are a method of propagation using woody cuttings harvested from specific species of trees or shrubs during the dormant season (**Table 1**) (**Figure 14** and **15**). Livestakes can be purchased from regional plant nurseries or harvested from your property if suitable species are present. The harvest and installation of livestakes should occur when the plants are dormant, generally from November to March. Livestakes should be 2-3 feet long and cut from branches that are 0.5-2 inches in diameter. The cut should be just below a leaf node to encourage rooting and angled to allow for easier installation into the ground (**Figure 16)**. Store livestakes by wrapping the cut ends in wet cloth until they are used and plant within a few days of harvest (**Figure 17**).

Table 1: Common species used for livestake installation.

Common Name	Species	Height (ft.)	Width (ft.)	Light Requirements
Black Willow	Salix nigra	70-80	30-60	FS, PS
Buttonbush	Cephalanthus occidentalis	5-8	3-6	FS, PS
Elderberry	Sambucus canadensis	9-12	6-12	FS, PS
Ninebark	Physocarpus opulifolius	5-8	6-10	FS, PS
Silky Dogwood	Cornus amomum	10-15	6-12	FS, PS, S

FS = full shade, PS = part shade, S = shade.

Figure 14: Livestakes were taken from a Black Willow (Salix nigra), Tag Alder (Alnus serrulate), and Buttonbush (Cephalanthus occidentalis). Photo credit: Katie Altman.

Figure 15: A livestake taken from a Black Willow (Salix nigra) has already begun growing three months after installation. Photo credit: Karen Jackson.

Figure 16: Cut livestakes just below a node to encourage growth. Photo credit: Katie Altman

Figure 17: A workshop participant installs a livestake with a slight angle downstream. Photo credit: Karen Jackson.

Figure 18: Livestakes should be spaced 3-4 feet apart and angled downstream to prevent debris build-up. Photo credit: Katie Altman.

Insert livestakes into the stream bank with ¾ of the stake in the ground. Insert livestakes approximately 3 feet apart in a triangular pattern with the stakes tilted slightly towards downstream (**Figure 18**). This angle will help prevent high flows from disturbing the livestake and prevent debris from building up. Installing the livestakes can be done by hand with a mallet. In hard soil, it may be necessary to create a pilot hole for each livestake, using a piece of rebar.

Livestakes are an inexpensive option to install native plants at a high density. If you would like more diversity along your stream, you can supplement your livestakes with container plants, herbaceous transplants, or plugs.

Practice 5: Create a no-mow or reduced mow zone

If time or financial resources do not allow for the practices above, use a no-mow or reduced mow area along the stream to protect the bank. Use a no-mow zone in addition to practices 3-6 to create a wider buffer. Reduced mowing will help to protect water quality and may reduce erosion issues. When mowing is stopped or significantly reduced along streams, plants will establish naturally based on the species already present in the soil or by species carried to your property from upstream. In this option, there is little control over what plants make up the riparian buffer. One drawback to this approach is the potential for invasive plants to establish. Learn to identify invasive plant species and how to remove them.

Maintenance

No landscape feature is maintenance-free; this also applies to stream bank repair projects. The following actions will help ensure stream bank repair projects are successful and long-living.

1. Install “no-mow” or “do not disturb” signs in the stream bank repair area (**Figure 19**). Tie bright flagging tape to livestakes to protect newly planted species.
2. Rope off the area to reduce disturbance, if necessary.
3. Communicate with any grounds crew that the area is not to be disturbed.
4. Check the site after high flow events and ensure erosion control matting is in place.
5. Water livestakes during the first few months if precipitation is low.
6. Monitor for and remove invasive plants as needed.
7. Remove excess debris after storm events.
8. Not all plants will survive. Replace as needed.

Figure 19: Install a “no-mow” sign near the buffer as a part of the maintenance plan. Photo credit: Katie Altman

Upland Best Management Practices

Responsible water management on adjacent upland property will give your riparian buffer the greatest chance of success. Best management practices help to reduce the volume of polluted stormwater runoff entering the stream. Best management practices include soil stabilization, rain gardens, rainwater harvesting, and replacing turfgrass with native plants. For more information, please visit:

Carolina Clear: Information on ways to prevent polluted stormwater runoff
clemson.edu/CarolinaClear.

Carolina Yards: Information on environmentally friendly yard care practices,including the plant database to assist with plant selection
clemson.edu/cy

Home & Garden Information Center (HGIC)
hgic.clemson.edu
Water Management in the Home Landscape, HGIC 1884
An Introduction to Native Plants for SC Landscapes, HGIC 1852
Pollinator Gardening, HGIC 1727

Rain Gardens: Information on rain garden design and implementation
clemson.edu/raingarden

Rainwater Harvesting for Homeowners (manual)
clemson.edu/extension/carolinaclear/files/RWHmanual.pdf

Figure 20: Workshop participants install a rain garden and rain barrel. These practices help to reduce the amount of runoff entering local waterways. Photo credit: Katie Altman

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